7. (a) What condition must be fulfilled before an alternator can be connected to an infinite bus?

   (b) At the time of synchronizing the frequency of incoming machine should be slightly higher than that of infinite bus. Justify.

   (c) Describe the two bright one dark lamp method of synchronizing one 3-phase alternator with another.

   (d) A turbo alternator is driving power to infinite bus at a lagging power factor. If steam supply to the turbine of this generator stops accidentally, explain what happens to the machine.

3 + 4 + 3 + 2 = 12

Group – E

8. (a) A 20 kW, 400 V, 3-phase, star connected synchronous motor has an effective synchronous reactance per phase of 4.5 Ω. The line voltage of developed back emf is 500 V. Calculate the motor power factor and current drown by the motor. Neglect armature resistance.

   (b) Explain why a synchronous motor is not self starting and what are the starting methods of synchronous motor?

   (c) Draw the phasor diagram of a salient pole synchronous motor operating at leading power factor load and also find the output power expression by neglecting the armature resistance.

4 + 4 + (2 + 2) = 12

9. (a) Define synchronizing power coefficient and give the physical concept of synchronizing power.

   (b) A 25 MVA, 3-phase star connected 11 kV, 10 pole, 50 Hz salient-pole synchronous machine, with negligible armature resistance, has reactance of Xd = 8 Ω and Xq = 4.5 Ω. At full load, 0.8 p.f leading and rated voltage, compute:
   (i) The exciting voltage.
   (ii) Power.
   (iii) Synchronizing power per electrical degree and corresponding torque.

(2 + 4) + (2 + 2 + 2) = 12

ELECTRICAL MACHINE-II
(ELEC 3101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and <u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i) The rotor power output of a 3-phase induction motor is 30 KW and corresponding slip is 4%. The rotor copper loss will be
   (a) 625 Watt (b) 250 Watt
   (c) 1000 Watt (d) 1250 Watt.

   (ii) As compared to DOL starting method the star delta starting method should have
   (a) high torque (b) low starting current
   (c) high starting current (d) smooth acceleration.

   (iii) A 3-phase 440 V, 50 Hz induction motor has 4% slip. The frequency of rotor current will be
   (a) 50 Hz (b) 25 Hz
   (c) 5 Hz (d) 2 Hz.

   (iv) The type of single-phase induction motor having the highest power factor at full load is
   (a) shaded pole type (b) split phase type
   (c) capacitor-start type (d) capacitor-run type.

   (v) The direction of rotation of a single phase capacitor run induction motor is reversed by
   (a) interchanging the terminals of the ac supply
   (b) interchanging the terminals of the capacitor
   (c) interchanging the terminals of the auxiliary winding
   (d) interchanging the terminals of both the windings.

   (vi) The crawling in the induction motor is caused by
   (a) high loads (b) low voltage supply
   (c) harmonic developed in the motor (d) improper design of machine.

(vii) Power factor of an alternator driven by constant prime mover input can be changed by changing its
(a) field excitation (b) phase sequence
(c) load (d) speed.

(viii) Armature reaction in synchronous generator at rated voltage and zero power factor (lead) is
(a) magnetizing (b) demagnetizing
(c) both magnetizing and cross-magnetizing (d) cross-magnetizing.

(ix) A synchronous capacitor is
(a) an ordinary capacitor bank
(b) an over excited synchronous motor on load
(c) an over excited synchronous motor on no load
(d) an under excited synchronous motor on no load

(x) A synchronous motor, connected to an infinite bus is working at a leading power factor. Its excitation voltage is
(a) $>V_t$ (b) $<V_t$
(c) $=V_t$ (d) $\leq V_t$.

Group – B

2. (a) A 3 phase, 50 Hz, 6 pole induction motor has a shaft output of 10 kW at 930 r.p.m. Friction and windage loss amount to 1% of output. Total stator losses are 600 W.
(i) Determine the rotor input and stator input.
(ii) If maximum torque is developed at 800 r.p.m., compute the starting torque with rated voltage starting.

(b) Explain the torque-slip curve for an induction machine showing its braking, motoring and generating region.

(3 + 3) + 6 = 12

3. (a) A 10 kW, 400 V, 3-phase, 4 pole, 50 Hz delta connected induction motor is running at no load with a line current of 8 A and an input power of 660 W. At full load, the line current is 18 A and the input power is 11.20 kW. Stator effective resistance per phase 1.2 Ω and friction, windage loss is 420 W. For negligible rotor ohmic losses at no load.
Calculate:
(i) Stator core loss.
(ii) Total rotor losses at full load.
(iii) Total rotor ohmic losses at full load.
(iv) Full load speed.
(v) Shaft Torque and Motor efficiency.

(b) Show that $Te = \dfrac{2Tem}{\dfrac{s_{mT}}{s} + \dfrac{s}{s_{mT}}}$ where, Te =motor torque; Tem=maximum motor torque; S_{mT} =slip at maximum torque.

(1 + 2 + 1 + 2 + 2) + 4 = 12

Group – C

4. (a) Briefly describe capacitor split-phase motor and draw its typical torque-speed characteristics.

(b) A single phase, 4 pole, induction motor takes a line current of $60\angle -70°$ A at standstill with its main winding excited from a 230 V, 50 Hz source. Neglecting stator impedance, magnetizing current and rotational loss. Calculate the torque at a slip of 0.05.

5 + 7 = 12

5. (a) Briefly describe resistor split-phase motor and draw its typical torque-speed characteristics.

(b) The following data relates to tests on a 110 V, 150 W, 50 Hz, 6-pole single-phase induction motor:
No-load test: 110 V, 63 W, 2.7 A
Blocked-rotor test: 55 V, 212 W, 5.8 A
The stator winding resistance is 2.5 Ω and during the blocked rotor test, the starting winding is open. Determine the equivalent circuit parameters. Also, find the core, friction and windage losses.

5 + 7 = 12

Group – D

6. (a) A 100 kVA, 3000 V, 50 Hz, 3-phase star-connected alternator has effective armature resistance of 0.3 Ω between the pair of terminals. A field current of 30 A produce short-circuit current of 100 A and open circuit e.m.f. of 1200 V between the pair of terminals. Find the voltage regulation of the alternator when it delivers full-load output at a pf of 0.8 leading.

(b) Discuss why the short circuit characteristic of an alternator is straight line where as open circuit characteristic is curved.

(c) Discuss the nature of armature reaction of an alternator for zero p.f lag and zero p.f lead.

4 + 4 + 4 = 12